A SIMPLE SYSTEM TO DETERMINE BEAM PROFILES AT RATES < 10^4 TO $\sim 10^{15}$ sec^{-1}

F. Hornstra, M. Atac, and M. Haldeman

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The operation of a proportional chamber with SWIC (Segmented Wire Ion Chamber)[1] electronics has been demonstrated by a group[2] at ANL to obtain profiles in a proton beam of $\sim 10^7$ sec^{-1} for E275 (Telegdi). Subsequently, the technique was demonstrated at NAL with a proportional chamber[3] and electronics developed here. Figure 1 is the resulting profile from a Ru^{106}, β (E_{max} = 3.54 MeV), source in our laboratory. Such a system allows the proportional chamber to operate at beam rates demonstrably one order of magnitude higher, but conceivably several orders of magnitude higher, than that possible with counting techniques. Moreover, the simplicity of the technique makes it attractive to monitor beams to the minimum possible rate. The features of the system can be summarized as follows:

1. The same chamber and electronics can cover a broad range of rates ($<10^4$ to $\sim 10^{15}$ sec^{-1} cm^{-2}) depending upon whether the chamber is operated with internal gain (up to 10^5) as a proportional chamber or with no gain as an ionization chamber (SWIC). Changes of gas mixture may be required over this range.
2. The electronics is simple and economical requiring only a capacitor and a FET (or relay) switch per channel.
3. No electronics is required on or near the chamber.
4. Several chambers may be connected in parallel to the same electronics. (Energizing the high voltage exclusively selects the chamber which presents charge to the electronics.)
5. Oscilloscope profiles are generated directly and simply by the electronics.
6. The electronics has stand alone capabilities and is easily portable.
7. Data can be easily digitized for a computer by one analog to digital (A/D) converter.

Figure 2 is a simplified schematic of the electronics. Each signal wire of the chamber is connected by a miniature coaxial cable to a capacitor which is connected to a bus by a normally-off MOSFET switch. The bus is connected to a high impedance amplifier. During a beam spill capacitors store the charge collected from each wire of the chamber. After the beam spill the switches are sequentially closed for a few μsec and then opened to yield the profile indicated in Figure 1. The capacitors are then discharged just preceding the next beam pulse. More detailed information is contained in the reference.[4]

We have demonstrated at NAL that replacing the MOSFET switches with reed relays allows integration over several machine cycles. The profile in Figure 2 had an integration time of one minute. Such an integration time permits beam intensities of $< 10^4$ particles sec^{-1} to be measured effectively.

Construction of simple scanners is proceeding and we anticipate this monitor to supplement, complement, and, in many cases, supplant counter electronics.

FOOTNOTES

[1] Hornstra, F., Simanton, J., Nucl. Instr. and Meth. 68(1969)138.

[2] Moffett, D. R., Bellinghausen, P., Private Communication, to be published in Nucl. Instr. and Meth.

[3] Atac, M., Martin, R. G., FN222, National Accelerator Laboratory, February, 1971.

[4] Hornstra, F., Simanton, J., Nucl. Instr. and Meth. 77(1969)303.

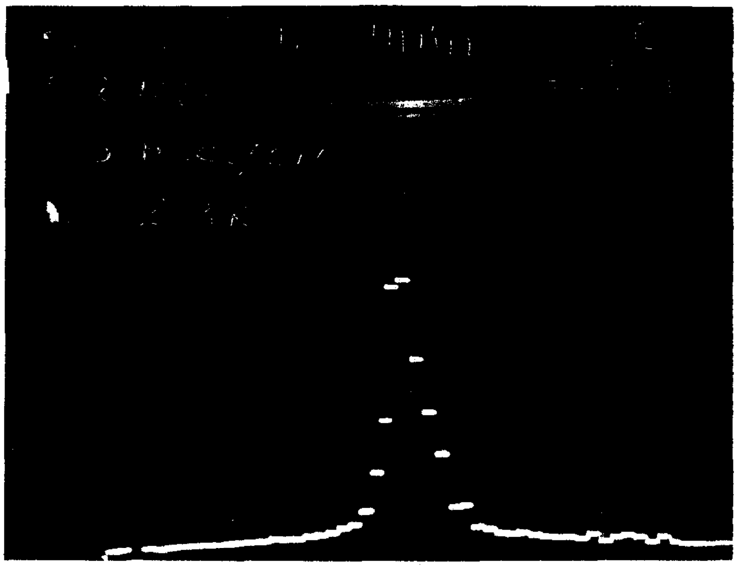

Fig. 1

Collimated Ru^{106}, β, source profile obtained with a SWIC scanner attached to a multiple wire proportional chamber.

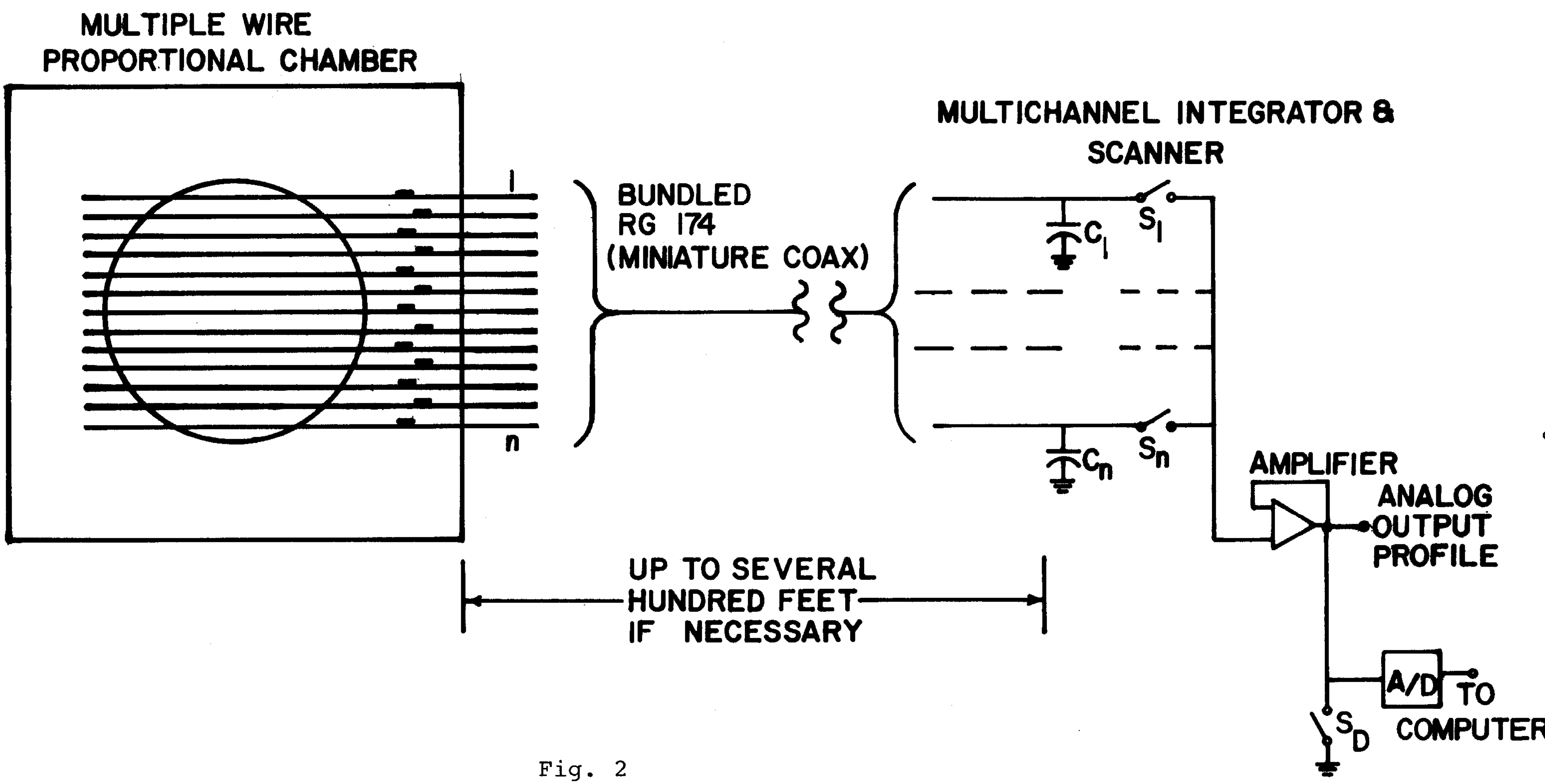

Fig. 2

Simplified schematic of multichannel integrator and scanner which obtains beam profiles from a multiple wire proportional chamber.

S_D IS USED TO DISCHARGE CAPACITORS

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